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## References

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## Malaria Control in South America

**To the Editor:** The article by Roberts et al. regarding DDT use and malaria in South America (1) correctly observes that health policy makers have shifted the emphasis of malaria control programs from vector control to case detection and treatment and that malaria control has been woefully underfunded in recent years. However, their conclusions that increased malaria is due to decreased spraying of homes with DDT and that DDT is still needed for malaria control do not withstand close scrutiny.

The authors did not mention several factors influencing malaria increase in recent decades, including growing antimalarial-drug resistance, the deterioration of public health systems responsible for malaria control, and large-scale migration to areas at high risk for malaria (e.g., almost all Brazilian malaria cases occur in the Amazon region) (2,3). Extradomiciliary malaria transmission, poor housing conditions, and human behavior in frontier areas such as the Amazon region limit the usefulness of insecticides. Thus, the deduction of causality between less house spraying with DDT and increased malaria incidence under those circumstances is questionable.

Roberts et al. have not actually linked increased malaria with eliminating DDT use but rather with eliminating house spraying altogether, without implementing effective alternatives. Malaria's recent decline in Brazil is due to a strategy that combines health education, aggressive case detection and treatment, and environmental management to eliminate *Anopheles* breeding sites (C. Catão Prates, unpub. data). A similar strategy has sharply reduced malaria incidence and deaths in Colombia (W.

Rojas, unpub. data). In Mexico, use of two synthetic pyrethroid insecticides (deltamethrin and lambda cyhalothrin) for bed-net treatment and house spraying is controlling malaria at a much lower cost than the use of the alternative insecticides tried earlier and mentioned by Roberts et al. (4). Far from being pursued "without meaningful debate," the reduction and phaseout of DDT and other persistent organic pollutants is the subject of a 3-year United Nations-facilitated global negotiation process begun in June 1998.

Roberts et al. assert that DDT applied indoors does not move easily from the application site; however, a mass balance model indicates that 60% to 80% of the DDT ends up outdoors within 6 months (K. Feltmate, A model and assessment of the fate and exposure of DDT following indoor application [bachelor's thesis]. Ontario: Trent University; 1998). From there, DDT can be transported long distances in air, waterborne sediments, and biota, accumulating in humans and other nontarget species (5). Meanwhile, residents of sprayed houses accumulate high, persistent body levels of DDT through skin contact and food contaminated with DDT from air and dust (6).

Long considered a probable human carcinogen, DDT also is associated with reduced lactation, premature births, absorbed fetuses, and lower birth weights (7-9). In addition, recent animal research has raised the possibility that exposure of human fetuses or infants to DDT may cause permanent behavioral changes and impairment of body systems (10-12).

Synthetic pyrethroid insecticides used on bed nets or for house spraying against malaria-infected mosquitoes seem safer for human health than DDT because humans and other mammals possess the ability to hydrolyze the pyrethroids rapidly and excrete them from the body (13-14). Nevertheless, DDT and pyrethroids share known health risks, notably endocrine disruption, and the possible transgenerational consequences of chronic human exposure to pyrethroids have not yet been studied (10,15-16). Optimal protection of human health requires the development of integrated malaria control strategies that eliminate or reduce routine insecticide use by taking maximum advantage of environmental management, biological controls, and other nonchemical vector control measures (17).

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## Malaria Control in South America— Response to P.C. Matteson

**To the Editor:** Dr. Matteson, whose letter relies heavily on unpublished information and nonrefereed publications, states that growing drug resistance has contributed to increasing malaria. While drug resistance is important, when DDT use declined below effective levels (1), the proportion of *Plasmodium falciparum* infections (including infections with resistant strains) compared with *P. vivax* infections (no resistance) did not progressively increase (2). Moreover, malaria has increased in Central America, where drug resistance is unknown (3-6). As for attributing increasing malaria to deteriorating public health systems, the changes imposed on developing countries (in organizational structures of malaria control programs and prohibiting DDT [1,7]) correlate with increasing malaria rates (1).

Dr. Matteson states that large-scale migration explains why almost all Brazilian malaria cases occur in the Amazon Basin. However, DDT cleared malaria from the more populated and temperate southern regions of the country (8, unpublished report: U.S. Agency for International Development review in 1973-74 of Brazil's malaria eradication program). When DDT was in full use (pre-1980), large increases in malaria did not accompany population movement (1). With the 1970s' colonization program of the Basin came malaria problems, but not large population-based malaria increases. DDT prevented that (1,9-11). However, since DDT has been eliminated, persistent urban malaria is again becoming a problem (12-16).

Other factors (biting behavior, housing conditions, and human behavior), which Dr. Matteson attributes to increasing malaria, have always thwarted interdiction of malaria transmission in the Amazon Basin (17;18; an unpublished report: U.S. Agency for International Development review in 1973-74 of the malaria eradication program in Brazil) and are no more important today than they were before.

A UN-facilitated global negotiation process cited as a meaningful debate for malaria control is an effort to provide a legally binding agreement for global elimination of DDT and other persistent organic pollutants, not an open forum for debate of DDT use for malaria control.